

North Delta Activities

WOCM1a: Construct a new water diversion facility in the north Delta with multiple intakes and fish screens and an isolated canal facility. Under this Conservation Measure, new water diversion facilities with a combined [redacted] cfs capacity would be designed, constructed, and operated on the Sacramento River between Walnut Grove and Freeport (*locations of intakes have not been determined at this time*). An isolated canal facility with a 15,000 cfs capacity would be constructed to convey water from the new diversion facilities to the south Delta, where it would join existing SWP and CVP diversion facilities. It is anticipated an eastern route of the isolated facility around the Delta would be preferable based on preliminary cost analysis and environmental effects associated with construction (*the exact location of the isolated canal facility has not been determined at this time*). However, this working assumption is subject to change if new information and analyses indicate that a different alignment is preferable. Each new intake would be screened with state-of-the-art positive barrier fish screens.

Selection of locations for multiple intakes and screen facilities along the Sacramento River between Walnut Grove and Freeport would be based on, but not limited to, maximizing function and effectiveness of screens; minimizing impacts to in-channel, on-bank, and terrestrial resources; applicable navigational and flood conveyance regulations; channel geometry and bathymetry; location relative to tidal influence and species range of covered fish; and proximity to other infrastructure (e.g., Sacramento Regional Wastewater Outfall, existing developed land, and other intakes). Each intake would be engineered to allow variable rate pumping to handle variation in the location of covered fish and tidally-induced flows, as well as sea level rise from climate change. The influence of tides, which could produce reverse or stagnant flows in channels, attenuates upstream such that the most northern intakes may be minimally influenced by tides, particularly during higher river flow.

Three types of screens are currently being considered for intakes: (1) on-bank screens; (2) in-river screens; and (3) cylindrical screens. There are differences in benefits, impacts, and costs of each that would be considered in the ultimate decision of which type to use. More than one screen type may be used depending on site conditions at each intake. Fish screens would be designed to include specific screen mesh sizes ([redacted] inch open area), approach velocities ([redacted] ft/sec), sweeping flows, screen cleaning mechanisms, and monitoring systems. Three types of screening materials are currently being investigated: stainless steel, copper-nickel, and plastic. The advantages and disadvantage of each would be considered in the ultimate decision of which material to use. Further, with the high risk of invasion into the Delta by quagga and zebra mussels in the future, the use of anti-fouling material or alternative cleaning systems is also being considered.

Various isolated canal facility routes are under consideration including routes on the east and west sides of the Delta. It is anticipated an eastern route of the isolated facility around the Delta would be preferable, although this assumption is subject to change if new analyses suggest that an alternative route is preferred. Once intake locations are determined, connecting conveyance facilities from the intakes to the head of the new

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canal would be determined. The isolated canal facility would include above and below ground portions and would connect to the existing south Delta SWP and CVP facilities at or in the vicinity of Clifton Court Forebay.

Adaptive Range. The adaptive range for operations of the north Delta facility is described in WOCM1b below.

Rationale: For decades, water has been diverted directly from the south Delta through SWP and CVP facilities to meet agricultural and urban water demands throughout California. These diversions have resulted in the development of reverse flows in major Delta channels, as well as entrainment of fish, invertebrates, nutrients, and other organic material. Existing diversion facilities are equipped with louvers that guide juvenile and larger fish into salvage facilities, where they are subsequently transported to release locations on the lower Sacramento and San Joaquin Rivers. Planktonic eggs and larvae are not effectively salvaged. The SWP also includes Clifton Court Forebay, which supports populations of predatory fish that prey on juvenile salmon and other fish before they can be salvaged.

The use of the Delta itself as a conveyance conduit for water exports has been one of a number of stressors to the Delta ecosystem, including toxic discharges, invasion of non-native species, degradation of natural habitat, unsustainable land use practices, changing climatic conditions, and large upstream diversions that, together, are thought to have negatively impacted covered fish species (see Section 3.4.2.2, Habitat Restoration Conservation Measures and Section 3.4.3.2, Other Stressors Conservation Measures). As a result of regulations to protect fisheries, water supply in California is less reliable than it has been historically.

Relocation and operation of the primary point of SWP and CVP water diversions from the south Delta to multiple facilities on the Sacramento River between Freeport and Walnut Grove and conveying water through an isolated facility is expected to provide a broad range of benefits to covered fish species, the Delta ecosystem, and water supply, including:

1. Substantially reducing entrainment of the larvae of covered fish species by reducing the spatial overlap of diversion intakes and covered fish species. The location of the existing south Delta export facilities is within the influence of covered fish species at least part of the year. However, the population centers of resident estuarine species, such as delta and longfin smelt, are downstream of the reach of the Sacramento River where the North Delta intakes could be installed (Wang 1986, Bennett 2005).
2. Substantially reducing entrainment and impingement losses of juveniles and adults of covered fish species by equipping facility intakes with state-of-the-art positive barrier fish screens. Such screens would be engineered to provide

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a maximum approach velocity to protect covered fish species when fish are within the vicinity of intakes.

3. Substantially reducing entrainment and impingement losses of juveniles and adults of covered fish species by constructing multiple intakes along the Sacramento River between Walnut Grove and Freeport. Multiple intakes would reduce the distance fish must travel past each fish screen, allowing individuals to rest between intake locations. Early estimates indicated that, if one 15,000 cfs intake were constructed, a single fish screen nearly a mile long would need to be constructed to meet approach and sweeping velocity criteria. This distance would expose fish to screens for longer periods, potentially exhausting them, reducing their swimming ability, and increasing their vulnerability to entrainment and/or impingement.
4. Substantially reducing entrainment and impingement losses of juveniles and adults of covered fish species by reducing water diversions in the tidal region of the Delta. Reverse flows associated with tidal oscillations increase the zone of influence of existing diversion facilities in many south Delta channels, potentially increasing the risk of entrainment of covered fish species. Relocating diversions farther upstream would reduce the tidal influence on diversions, which would reduce entrainment of covered fish species. Further, for positive barrier fish screens to function properly to minimize fish entrainment risk, a minimum unidirectional sweeping velocity must be maintained. Opportunities for such velocity improve as tidal influence decreases farther upstream.
5. Reducing the export of nutrients, phytoplankton, zooplankton, macroinvertebrates, and other organic material from the estuary by relocating the diversion intakes to the north Delta. The location of existing south Delta diversion facilities is thought to be in an area with higher concentrations of export of nutrients, phytoplankton, zooplankton, macroinvertebrates, and other organic material than of the new proposed reach of the Sacramento River. As a result, the loss of Delta productivity is expected to be lower if water is diverted at north Delta facilities compared to existing south Delta facilities.
6. Improving fishery and aquatic habitat within the Delta by improving hydrodynamics within the Delta channels. Existing flow patterns in the Delta have been altered to maintain high quality water in the south Delta for project exports, as well as agricultural and other urban water uses. Such alterations include north to south flows through the man-made Delta Cross Channel and reverse flows in Old and Middle Rivers. There is less need to maintain high water quality in the south Delta when high quality water is diverted from the north Delta, resulting in more natural flows through the Delta.
7. Reducing or eliminating mortality of covered fish species associated with collection, handling, transport, and release of salvaged fish from the existing

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export facilities and predation within these facilities by constructing in-river or on-river facilities along the Sacramento River.

8. Improving water supply reliability and flexibility under conditions of future environmental change. Because of their location, new diversion facilities would withstand future sea level rise in ways that existing diversion facilities would not. Multiple intakes would add flexibility in operations to handle variation in the location of covered fish and tidally-induced flows.
9. Increasing residence time, and therefore productivity, in the interior Delta by reducing artificial flows through the Delta. Existing Delta operations promote north to south flow of water via the Delta Cross Channel to compensate for higher salinity and lower supply water from the San Joaquin River. By reducing South Delta diversions, less water must move from north to south, resulting in increased residence time of nutrients and organic matter, allowing these materials to be assimilated into the Delta food web.
10. Providing greater opportunity for physical habitat restoration and enhancement, including habitat restoration in the western, eastern, and southern Delta, by reducing the reliance upon through-Delta conveyance via the Delta Cross Channel and intakes in the south Delta. Decreased south Delta pumping would reduce the export of production that may result from restored habitat, as well as reduce the need to keep salinity and concentrations of organic material artificially low in these parts of the Delta.
11. Substantially reducing the effects of existing water projects on salmonids in the San Joaquin River system and tributaries, Mokelumne River, and other east side tributaries by reducing through-Delta conveyance. Such artificial flow patterns are thought to entrain outmigrating juvenile salmonids in these channels towards the pumps and confuse the upstream migration cues of adults.
12. Allowing implementation of other conservation measures focused on non-flow and non-habitat related by emulating more natural physical patterns (e.g., salinity regimes, flow patterns) and processes in the Delta under which native resident species evolved. For example, a change in the hydrograph could favor native species by providing proper timing of ontogenic physical cues, such as those needed to initiate upstream or downstream migration, and create conditions that disfavor non-native species, such as reduced summer inflows, which are currently higher than would occur naturally.

Implementation timeframe: Construction of a new diversion and screen facilities on the Sacramento River would require major engineering design, hydrodynamic analyses, environmental documentation (to be addressed by the BDCP EIR/EIS), state and federal permitting, land acquisition, and major construction activity. Construction is expected to begin within ##-## years after the BDCP is adopted and is expected to be completed in ##-## years. Completion

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of north Delta diversion facilities, the isolated canal facility, and associated project components would mark the beginning of the long-term implementation period of the BDCP.

Implementation considerations: Implementation of new intake and screen facilities and an isolated canal facility would require extensive engineering design, geotechnical investigations, site and alignment planning, land acquisition, site preparation, and construction. Key issues for implementation include, but are not limited to, the design criteria (e.g., screen mesh size, approach velocity, sweeping velocity) for the positive barrier fish screen, the location of the points of diversion (intakes and fish screens) within the Sacramento River, size and diversion capacity of each intake structure, operational criteria, magnitude of water supply diversions, alignment of the canal, and the location of support facilities such as power supplies and diversion pumps. Terminal delivery and check structures would be needed to integrate new and existing conveyance in the south Delta, and to provide for the use of existing CVP and SWP pumps for re-lift of water into the existing CVP and SWP canals. Determination of facility locations and canal alignment would consider effects to sensitive habitat and existing land use. Operation of the new facilities would have to be integrated and coordinated with the operation of existing CVP and SWP facilities as guided by the Coordinated Operations Agreement (PL-99-546).

Intake structures would require excavation, dredging, modifications to the existing Sacramento River levees, construction of intake head works, hydraulic controls, as well as a number of associated features such as additional diversion and conveyance pumps, power supplies, access roads, equipment storage, and other operations and maintenance facilities. Any effects of the structures and operations to other in-Delta diverters and dischargers would be identified and resolved. Effects to flood capacity for in-river intakes or effects to levees for on-bank intakes would be considered in intake design. In-river intakes would comply with navigation requirements of the U.S. Coast Guard, U.S. Army Corps of Engineers, and Department of Boating and Waterways. With the high risk of invasion into the Delta by quagga and zebra mussels, the use of anti-fouling screen material or alternative cleaning systems would be considered.

Construction of these facilities would require a number of authorizations, including state and federal ESA authorizations for take, a Clean Water Act section 404 permit and 401 water quality certification, Reclamation Board encroachment permits, Rivers and Harbors Act section 10 permit, and California Fish and Game Code section 1602 agreement. Operation of the facilities would also require consultation under state and federal ESA statutes and either new or modifications to the existing SWRCB water rights permits for both the state and federal water projects. A project level EIR/EIS would need to be prepared under NEPA and CEQA.

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There would likely be challenges to implementing this conservation measure by local landowners whose lands may be impacted by new facilities and by water users throughout the watershed that may be affected by changes in water quantity and/or quality.

Resiliency to future changes: New diversion facilities would be physically designed to be resilient to future changes in hydrology, sea level rise, and implementation of other elements of the overall BDCP conservation program. The diversion would be located on the Sacramento River in an area where channel capacity and levees are designed to accommodate a wide range of river flows. Although the frequency, duration, and magnitude of seasonal flows within the Sacramento River may vary in the future, the function and biological benefits associated with the positive barrier fish screens, operations of the diversion facility, and reliability of the water supply system would continue into the future over the range of anticipated changes in future hydrologic conditions. Implementation of a diversion on the Sacramento River would add flexibility to the water supply system by increasing the number and geographic locations (dual facility operations in the south and north Delta and the array of north Delta intakes) where water may be diverted in the future. In addition, screens on intakes would be designed to reduce or eliminate fouling by future invasions of non-native species, such as zebra and quagga mussels.

Uncertainties/risks: Although it is anticipated that diverting water from locations north of the Delta will improve overall ecosystem function and substantially decrease entrainment in the south Delta, the population level response of covered species to this parameter is uncertain, largely because numerous other non-flow factors are responsible for their decline, including food limitation, invasive species, discharges of contaminants, and increasing temperature trends. Even if construction and operation of north Delta facilities completely eliminates negative effects to covered species by exports from the Delta, other stressors may ultimately result in failure of these species to recover. Therefore, although results of studies conducted at other fish screen sites have shown significant reductions in fish loss, quantification of the overall benefits of reducing entrainment mortality to the population dynamics and long-term abundance of covered fish species is uncertain.

The proposed new screen facilities would be the largest array of fish screens ever built. Uncertainties exist regarding facility maintenance requirements (e.g., debris loading and cleaning, sediment accumulation and the needs for periodic dredging and removal) at the scale and location of the new facilities, as well as long-term repair and replacement of fish screens, flow controls, and pumping facilities. Uncertainties also exist regarding the performance of the fish screens in reducing

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1 entrainment of fish eggs and larvae, movement of juvenile and adult fish past the
2 fish screen, and the potential accumulation of predators.

3
4 **Monitoring and adaptive management considerations:** *[Note to reviewers: this*
5 *section is a general summary; more detail will be provided in future iterations.]*

6 Monitoring the performance of a positive barrier fish screen includes periodic
7 velocity measurements across the screen surface to confirm compliance with the
8 approach velocity design criterion. In the event that approach velocities are not
9 uniform across the screen surface, or exceed the design criterion, louver baffles or
10 other structures located behind screens are adjusted to regulate screen porosity
11 and approach velocities. Monitoring would include evaluation of the head loss
12 across the screens, which serves as an indication of changes in porosity associated
13 with debris accumulation, river flows and river stage, and changes in sediment
14 accumulation immediately outside and inside of the intake structure.

15
16 **Reversibility:** Because significant infrastructure would be constructed, this
17 conservation measure is not easily reversible.

18
19 **WOCM1b: Preferentially operate a new water diversion facility in the north Delta**
20 **and maintain sufficient bypass flows for covered fish species.** The north Delta
21 diversion facility would be operated in conjunction with, but preferentially to, existing
22 south Delta SWP and CVP diversion facilities to minimize adverse effects on fish in the
23 Delta while supporting diversions as described in Chapter 4 *Covered Activities*. The
24 quantity and timing of diversions would be affected by specific parameters described in
25 this document.

26
27 The new intake facilities would be operated to maintain specified flows in the
28 Sacramento River as it bypasses new north Delta facilities for environmental benefits.
29 These north Delta facilities “bypass flows” represent the rate of flow at which the
30 Sacramento River must pass downstream of the new diversion points. Diversion of water
31 from the north Delta facilities would be managed and limited based on compliance with
32 bypass flow requirements. To meet water supply goals (see Chapter 4 *Covered*
33 *Activities*), constraints to the amount of water diverted from north Delta facilities would
34 require commensurate increases in diversions from the south Delta SWP and CVP
35 facilities. This parameter affects WOCM4, 6, 9, 10, 13, and 14.

36
37 **Adaptive Range.** The north Delta facilities operations and bypass flow requirements
38 would apply in the BDCP long-term implementation period following completion of
39 facilities construction. The isolated facility would convey up to 15,000 cfs of water. The
40 operations and bypass flow criteria are described, by water-year type, in Table 2 *[not*
41 *provided at this time, values to be determined]*. Initially, exports would be split between
42 those diverted from the north Delta facility and those diverted from the south Delta;
43 however, as sea level rise and Delta levee failures reduce the feasibility of pumping

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1 directly from the south Delta, annual exports delivered through the isolated facility is
2 expected to increase.

3
4 **Rationale:** The Sacramento River, in addition to its upstream tributaries, is the
5 primary migration corridor and spawning/rearing habitat for Chinook salmon,
6 Central Valley steelhead, and green and white sturgeon within the Central Valley.
7 Further, both delta smelt and longfin smelt are thought to spawn in the lower
8 Sacramento River (Wang 1986, Bennett 2005). Important fishery issues with
9 respect to seasonal river flows include: (1) adult Chinook salmon, steelhead, and
10 green and white sturgeon attraction flows and upstream migration; (2) juvenile
11 Chinook salmon and steelhead downstream migration; (3) downstream transport
12 of planktonic fish eggs and larvae; (4) downstream transport of food and other
13 organic material; and (5) habitat for both resident and migratory covered fish
14 species within the lower Sacramento River. The importance of river flows to each
15 life stage of the covered fish species varies seasonally depending on each species'
16 life history and habitat requirements. Because of the importance of the
17 Sacramento River as a migration route and habitat for covered fish species,
18 concern has been expressed regarding maintaining sufficient flows within the
19 river to support covered fish species.

20
21 The diversion of water from the Sacramento River through facilities located
22 between Freeport and Walnut Grove directly affects flows within the river
23 downstream of the points of diversion. Of particular concern are flow rates within
24 Sutter and Steamboat Sloughs (see WOCM4 below). These sloughs are major
25 migration corridors for juvenile Chinook salmon and probably other native
26 species. Survival rate of these species is thought to be higher in these sloughs than
27 in the interior Delta. Higher downstream flows and lower reverse flows would
28 likely result in lower exposure to predation and, therefore, greater probability of
29 survival. Non-native predators present throughout the Delta are thought to be a
30 primary cause of in-Delta salmon mortality (see *Other Stressors Conservation*
31 *Measures*). If flows in Sutter and Steamboat Sloughs are reduced, residence time
32 and, therefore, exposure to predators of outmigrating species, is expected to
33 increase. Attraction flows for adults can also be reduced if flows are reduced in
34 these channels. Analyses to date, however, indicate that substantial habitat
35 restoration in the Cache Slough area, in combination with bypass flow
36 requirements for the north Delta diversions, would enhance downstream flows in
37 Sutter and Steamboat sloughs substantially above those present under pre-Wanger
38 conditions without an isolated facility (A. Munevar unpubl. data).

39
40 Reduced flows on the Sacramento River downstream of the diversion can affect
41 downstream transport of food, organic material, and multiple life stages of
42 covered fish species. Developing bypass flow criteria for the north Delta
43 diversion facilities involves consideration of the seasonal timing of various life
44 stages of covered fish species within the lower Sacramento River, relationships

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between river flow, water velocity, transport time, and residence time, and the growth, survival, and distribution of various life stages of the covered species.

North Delta facilities bypass flows also affect the sweeping velocities across the surfaces of intake fish screens, the potential exposure duration of a fish to the screen, local current patterns and hydrodynamics in the vicinity of the screen surface that may affect fish entrainment or impingement, debris loading, effectiveness of fish screen cleaning mechanisms in removing debris from the screen surface, and maintaining a uniform approach velocity within the screen design criterion.

Implementation timeframe: Completion of north Delta diversion facilities, the isolated canal facility, and associated project components would mark the beginning of the long-term implementation period of the BDCP. The north Delta facilities operations and bypass flow requirements would become effective during the BDCP long-term implementation period.

Implementation considerations: Operation of the north Delta facilities would be subject to appropriate diversion limitations based on bypass flow requirements and constraints on south Delta pumping (WOCM4, 6, 9, 10, 12, and 14). Implementation of the north Delta facilities bypass flow requirement includes consideration of biological processes both downstream of the north Delta diversion facilities and in the south Delta. More demanding bypass flow requirements would result in less water diverted in the north Delta facility and commensurate increase in south Delta diversions from the existing SWP and/or CVP export facilities. The ecological tradeoffs between pumping in the south Delta and diversion from the north would need to be carefully monitored, with bypass flow requirements adjusted accordingly through adaptive management (see below). In the south, greater through-Delta conveyance is expected to result in greater entrainment of organic material and fish, greater reverse flows in key channels, and potentially less successful in-Delta habitat restoration efforts.

The operation of new facilities may require modification of the operations of upstream reservoirs. This would require modification of the various agreements and licenses governing the operation of these reservoirs. This may require changes in minimum instream flow requirements, minimum drawdown levels, flood control operations, temperature standards, and riparian and geomorphic flow requirements. Such modifications may require modification of Clean Water Act section 404 permits for these projects, as well. Additionally, hydroelectric facilities may need modifications to their FERC licenses.

Implementation of bypass flow requirements would require consideration of: (1) variation in precipitation and hydrology of the Sacramento River within and among years; (2) seasonal timing of various life stages of covered fish occurring

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near and downstream of the facilities; and (3) the relationship between river flows and physical and biological processes that affect survival, growth, and abundance of covered species, including downstream transport of food and organic material and distribution of covered species. Diversions into floodplain habitat (WOCM3 and 4) would also affect availability of water to support bypass flows.

Implementation of the bypass flow requirement could unintentionally affect operation of upstream reservoirs, with operators holding back releases during periods of high bypass requirements (winter and spring) and maximizing releases during more relaxed bypass requirements during the summer in the mainstem Sacramento River. Implementation of the bypass flow requirement would require a large-scale management effort to coordinate and integrate SWP and CVP water project operations throughout the Central Valley. Flow rates within Sutter and Steamboat sloughs must also be considered in the implementation of bypass flow criteria.

Minimum bypass flows would also be determined by required sweeping and approach velocities across the surfaces of intake fish screens, the potential exposure duration of a fish to the screen, local current patterns and hydrodynamics in the vicinity to the screen surface that may affect fish entrainment or impingement, debris loading, and the effectiveness of fish screen cleaning mechanisms in removing debris from the screen surface, and maintaining a uniform approach velocity within the screen design criterion.

Resiliency to future changes: Operations of the new north Delta facilities would be highly flexible and adaptable to future changes. As sea level rise and Delta levee failures reduce the feasibility of pumping directly from the south Delta and, therefore, reduce water supply reliability, diversions from north Delta facilities are expected to increase with a concomitant decrease in south Delta diversions to maintain water supply reliability. Further, geographically distributed intakes in the north Delta would be operated individually to divert water according to flow rates and distribution of higher quality water and covered fish species. Changes in habitat conditions within the Sacramento River upstream and downstream of intakes of the north Delta facilities in the future may alter relationships between Sacramento River flows and the health and survival of covered fish species. In addition, changes in precipitation patterns, both in terms of the quantities of precipitation within a year but also variation in the amount of precipitation as rainfall and snowfall, will also affect the frequency and magnitude of flows in the Sacramento River in the future.

The proposed criteria for bypass flows (Table 2 [*not provided at this time, values to be determined*]) are designed to reflect variation in hydrological conditions within the basin, and specifically within the river at the points of diversion, and therefore would be resilient to future changes in hydrology. Bypass flow requirements can be modified as necessary to adapt to future changes in

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hydrology, sea level, implementation of other conservation measures, and changes in habitat conditions.

Uncertainties/risks: As described in WOCM1a, even if construction and operation of the north Delta facilities eliminates the negative effects of exports on covered fish species, the species populations may not recover due to the large number of other non-flow related stressors affecting the species. There are also uncertainties related to how covered species will respond to various operational aspects of a north Delta facility, which are covered in more detail in the descriptions of other conservation measures below.

Monitoring and adaptive management considerations: *[Note to reviewers: this section is a general summary; more detail will be provided in future iterations.]*

Monitoring would include diversion rates and river flow to determine compliance with the required river bypass flows. Diversion rates can be adaptively managed based on changes in river flow rates (e.g., tidal velocities and flows), as well as in response to the occurrence of the early life stages of various fish that are more difficult to exclude from entrainment by fish screens. Biological monitoring may also include investigation to determine the migration rates and patterns of fish past fish screens, changes in the abundance and distribution of predatory fish in the vicinity of the intake structure, the seasonal occurrence of various life stages of fish in the area, estimates of survival of fish migrating through the Sacramento River and Delta, and investigations of the population-level effects of the conservation program on covered fish.

Results of the biological monitoring could be used adaptively in a variety of ways that include, but are not limited to: (1) changes in diversion operations within a range of adopted diversion parameters that are based on “real-time” monitoring of the occurrence of eggs and larvae of covered fish in the area; (2) selectively operating diversions based on the geographic distribution of covered fish within the river; and (3) changing diversion operations based on tidal velocity and river flows to increase sweeping velocity and the rate of fish movement past fish screens.

Given the numerous uncertainties described above, it is important to develop appropriate monitoring and adaptive management criteria to evaluate the response of covered fish species to the bypass flow criteria. The impact of modifying bypass criteria on other operational parameters, particularly the level of pumping in the south Delta, would be examined, and the overall impact on covered species and ecosystem health would be evaluated. Future monitoring would include examination of relationships between bypass flows and south Delta pumping levels on survival and abundance of various life stages of covered fish species. Monitoring is also expected to examine the relationship between river flows and the downstream transit times for larval and juvenile fish, nutrients and organic

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1 carbon sources, as well as the behavior (e.g., transit rate, residence times, and
2 upstream and downstream tidal movement) of various fish in the immediate
3 vicinity of a positive barrier fish screen. Operational monitoring at one or more
4 points of diversion is expected to include approach and sweeping velocities as a
5 function of both river flows and diversion rates, debris loading and cleaning of the
6 fish screen, sediment deposition and scour within the river in the vicinity of the
7 points of diversion, and changes in fish screen and diversion operations over a
8 range of river stages and flow rates.
9

10 Results of both biological and operational monitoring throughout the Delta could
11 be used within the BDCP adaptive management framework to refine and modify
12 river bypass flow rates. For example, additional information on the actual timing
13 of fish migration downstream within the Sacramento River within a given year
14 could result in near-term modification to the river bypass flows to facilitate
15 migration past the points of diversion and fish screens.
16

17 **Reversibility:** Facilities operations and bypass flow requirements could be easily
18 modified or reversed. However, because bypass flow requirements are an integral
19 element in overall water project operations, water supply deliveries, and
20 environmental protections for species and habitats within the lower Sacramento
21 River, institutional reversibility is expected to be difficult.